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Generalized Phase contrast and matched filtering for speckle-free patterned illumination

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Generalized Phase Contrast (GPC) and matched-filtering GPC use tandem diffractive phase elements on Fourier-conjugate planes of a 4*f* optical processor to efficiently reshape incident light into a pattern that resembles the input phase modulation pattern. The synthesized patterns are inherently speckle-free and the use of phase modulating elements minimizes absorption losses to maximize light efficiency as light is simply redistributed from the dark regions to the intense regions of the output pattern. Besides its successful application for spatially precise and reconfigurable targeting to optically trap and mechanically manipulate microparticles, GPC has also been applied for laser beamshaping, optical phase cryptography, and greyscale image projection. Recent reports from our collaborators highlight that GPC-based spatial lightshaping, when combined with temporal focusing and multiphoton excitation, exhibits some robustness against light scattering and, hence, makes a promising tool for spatially precise targeting of deeper subsurface neurons using minimally speckled patterned illumination for multiphoton excitation.